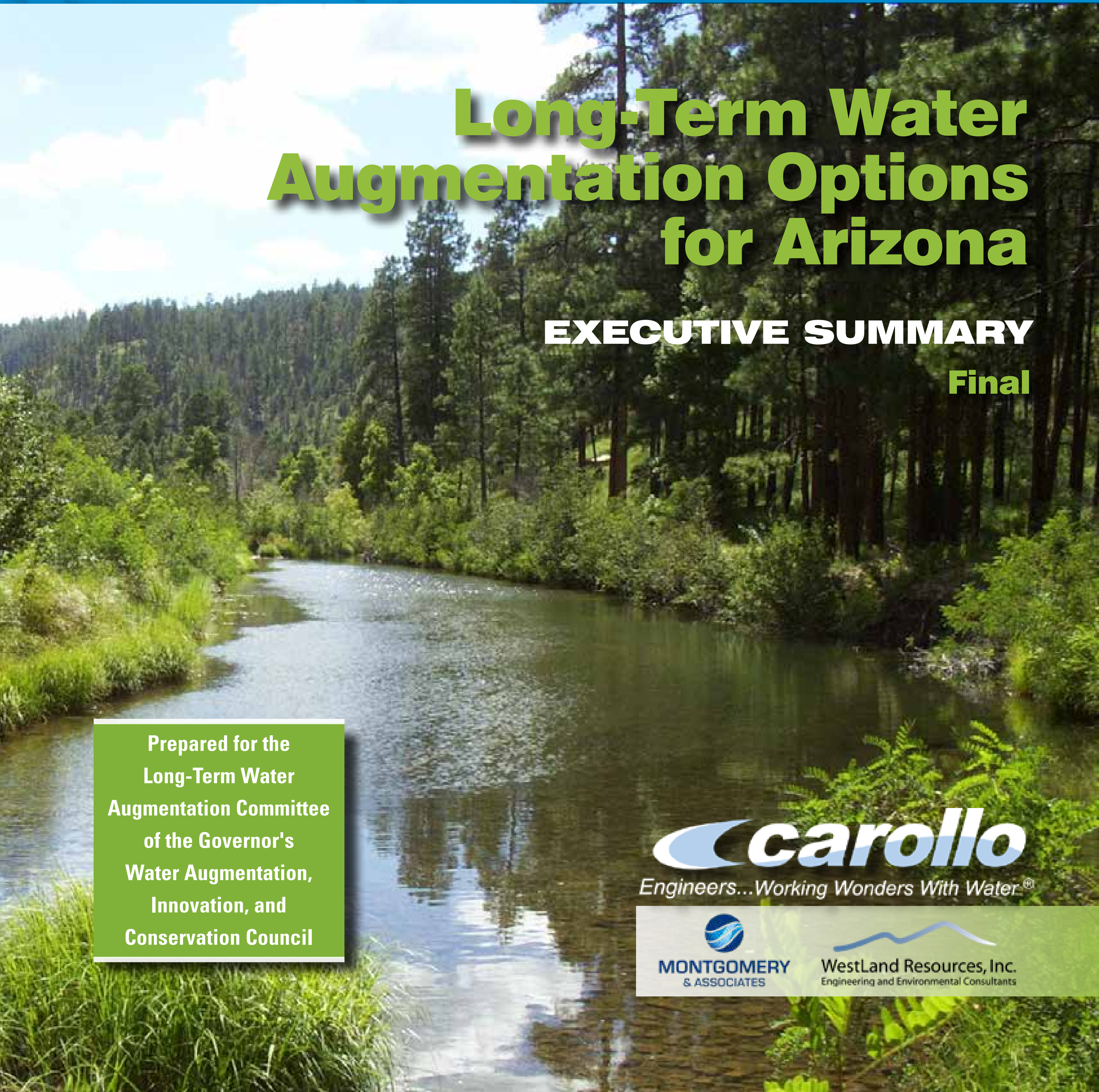
AUGUST 2019

Long-Term Water Augmentation Options for Arizona

EXECUTIVE SUMMARY

Final



Prepared for the Long-Term Water Augmentation Committee of the Governor's Water Augmentation, Innovation, and Conservation Council

carollo
Engineers...Working Wonders With Water®

MONTGOMERY & ASSOCIATES

WestLand Resources, Inc.
Engineering and Environmental Consultants

INTRODUCTION

This project was initiated by the Long Term Water Augmentation Committee of the Governor's Water Augmentation Council (GWAC) which is now the Governor's Water Augmentation Innovation and Conservation Council (GWAICC).

The Committee provided guidance to the project team consisting of Carollo Engineers, Montgomery and Associates, and Westland Resources, Inc. to evaluate water augmentation options for the twenty-two water planning areas throughout Arizona.

The outcomes of this study are to be viewed as a menu of options that water users in each planning area can select from to increase their water supplies. The responsibility for selecting and implementing water augmentation options is up to the entities in each planning area that want to increase water supplies and are willing to fund the cost of additional water supplies.

Funded by the Arizona Department of Water resources and a grant from the Bureau of Reclamation Phoenix Area Office Water Conservation Field Services Program.

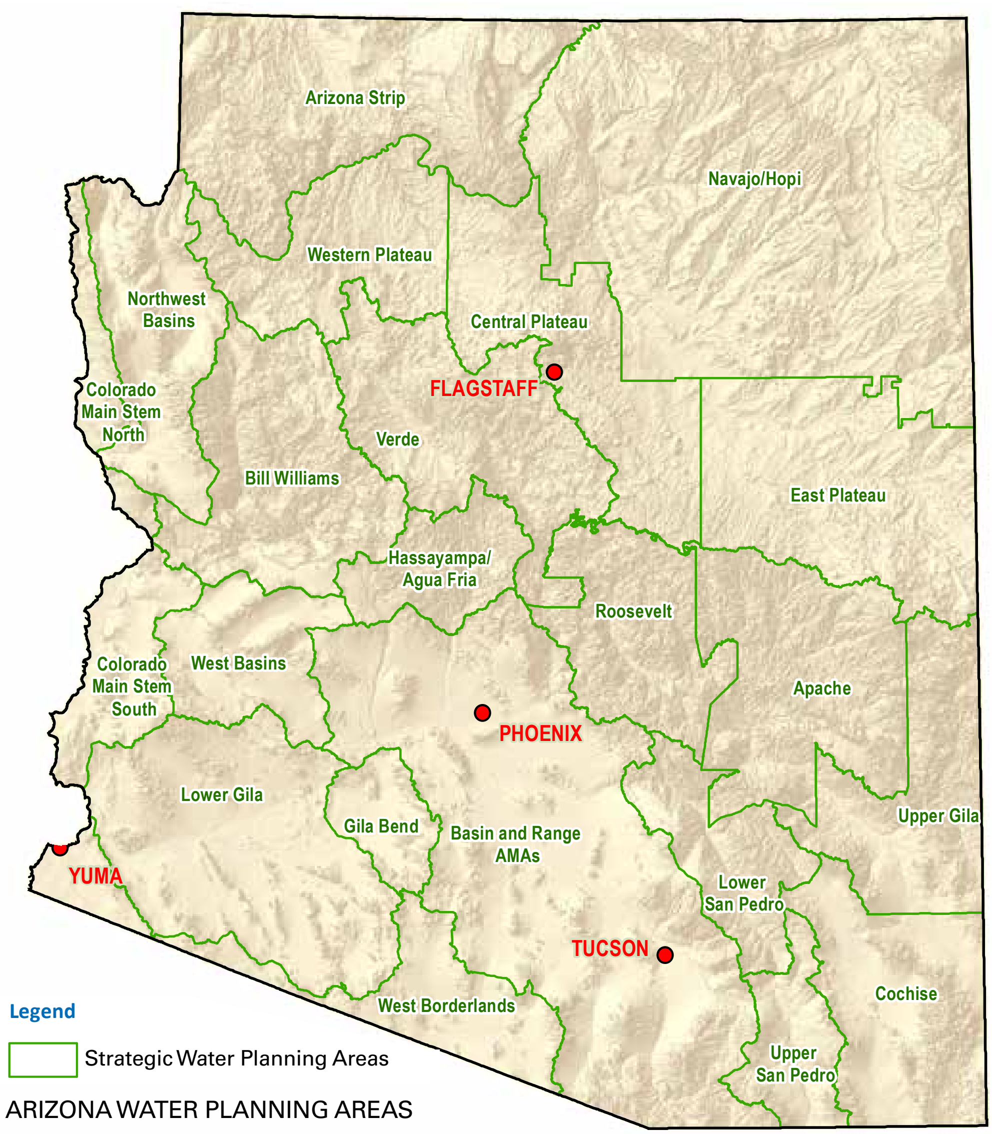
PURPOSE

The purpose of this water augmentation project is to identify water augmentation options that the twenty-two different water planning areas in Arizona could take as ideas to augment water supplies. Objectives included:

- Identify state-wide water augmentation opportunities including rural planning areas.
- Look for Arizona's next large water supply.
- Combine multiple water augmentation methods to increase water supply benefits.

PLANNING AREAS, AUGMENTATION OPTIONS

The graphic below presents the twenty-two Arizona planning areas. The table on the following page presents suggested water augmentation options that are an outcome of this study, organized into the following categories: water augmentation, best practices, projects and practices between willing parties that improve water utilization, and water augmentation concepts requiring further development. Impediments to water augmentation are also addressed.



ARIZONA WATER PLANNING AREAS

WATER AUGMENTATION OPTIONS

Water Augmentation Options	Best Practices that Improve Water Use Efficiency	Projects and Practices Between Willing Parties that Improve Water Management	Water Augmentation Concepts Requiring Further Development
Ocean Desalination	Agricultural Water Conservation	Water Supply Transfers for CAP and Colorado River Water Users	Weather Modification
Brackish Groundwater Desalination	Enhance Aquifer Storage	Modify Operation of the Roosevelt Dam to use the Flood Control Space	Phreatophyte Management
Groundwater Transfers from the Harquahala and Butler Groundwater Basins	Reclaimed Water Utilization	SRP-CAP Interconnect Facility	Watershed Management
	Municipal Water Conservation		

Impediments to Water Augmentation		
Little Colorado River and Gila River Water Rights Adjudications	Unresolved Indian Water Rights Claims	Groundwater Management Planning

Water Augmentation Options

Water Augmentation Option 1

OCEAN DESALINATION

Minute 323 entitled "Extension of Cooperative Measures and Adoption of a Binational Water Scarcity Contingency Plan in the Colorado River Basin," was entered into force on September 21, 2017 and included delegates from the United States, Mexico and the International Boundary and Water Commission (IBWC). In Section IX. B of Minute 323, "New Water Sources Projects," opportunities exist for joint cooperative projects with the potential to increase delivery or exchange of Colorado River water benefiting both the United States and Mexico, which include the following projects:

- Binational Desalination Plant at the Pacific Ocean coast;
- Binational Desalination Plant in the New River;
- Binational Desalination Plant, Sea of Cortez;
- Reuse of the effluent from the Mexicali Valley wastewater treatment plants in wetlands or riparian restoration of the Colorado River; and
- Re-use in the United States of South Bay International Wastewater Treatment Plant effluent.

The Minute directed the formation of a Binational Desalination Work Group comprised of Federal, State, and water agencies from the United States and Mexico which would study potential new water sources projects. The next action tasked to the Binational Desalination Work Group is the development of a study of water desalination opportunities in the Sea of Cortez. The study is a preliminary investigation to identify the range of possibilities for potential future development of binational desalination opportunities that provide benefits to water users in the United States and Mexico. A consultant to conduct the study has been selected and the project is currently underway. The consultant's team will include engineering, desalination, and environmental experts from both Mexico and the United States. They will evaluate technical and environmental issues that include:

- Local and regional current and future unmet water needs in Sonora and Baja California, Mexico, and the lower Colorado River Basin, United States;
- Various desalination technologies that could be applicable in the region;
- Potential desalination opportunity locations along the Sonoran coast; and
- Possible impacts to the marine environment, flora and fauna.

The study will include recommended desalination concepts to consider for possible additional investigation and is scheduled to conclude in 2020.

This binational work group is the path for Arizona to consider opportunities for desalination projects with Mexico.

Water Augmentation Option 2

BRACKISH GROUNDWATER DESALINATION

Brackish groundwater is water that has high levels of Total Dissolved Solids (TDS) and requires treatment before it can be used as a potable water supply. Brackish groundwater is located in multiple planning areas throughout Arizona, including: Basin and Range, Gila Bend, Navajo/Hopi, Cochise, Lower Gila, West Borderlands, Colorado Main Stem South, Central Plateau, Eastern Plateau, Northwest Basins, and Upper Gila water planning areas. The volume of brackish groundwater that can be recovered varies between 6,000 and 10,000 acre-ft per-year (AFY) in most of these planning areas. The Buckeye waterlogged area in Maricopa County might yield up to 50,000 AFY, and Yuma area desalination would yield more than 10,000 AFY.

Brackish groundwater treatment usually requires Reverse Osmosis (RO) treatment process which produces a brine stream that is expensive to manage. Brine Management options include:

- Brine evaporation ponds
- Deliver to an industrial facility for use in cooling towers
- Deep well injection
- Thermal Brine Concentration
- Vacuum Membrane Distillation

A Brackish groundwater treatment project consists of multiple wells, an RO treatment facility, a brine management system, potable water storage tanks, pumping, and a pipeline delivery system. For a facility capable of delivering 10,000 AFY (9 mgd) and TDS levels near 3,000 mg/L, the cost may vary between $1,500 and $2,000 per acre-ft (AF) of treated potable water. Brackish groundwater development at this cost is more likely to occur in the future when the price of water increases to the point that brackish groundwater supplies become economically viable.

Reverse Osmosis Facility in Goodyear, Arizona

Deep Well Injection Facility

Thermal Brine Concentration Facility

Water Augmentation Option 3

GROUNDWATER TRANSFERS FROM THE HARQUAHALA AND BUTLER GROUNDWATER BASINS

The Harquahala and Butler Valley alluvial groundwater basins are located west of Tonopah, AZ. Arizona State Statute allows groundwater from the Harquahala and Butler Valleys to be withdrawn and delivered to the Basin and Range Active Management Area (AMAs) by wheeling this water through the Central Arizona Project (CAP) Canal. Planning and development to extract this groundwater is underway by the several parties that own land in Harquahala. Additional supplies may come from the Butler Valley. When land ownership requirements are met, the McMullen Valley could also have groundwater extracted for potable use.

Developing this groundwater supply requires wells, transmission lines, pump stations, storage, and delivery into the CAP canal. Groundwater may need to be treated before it is placed in the CAP canal. Then at the delivery point, a diversion from the CAP canal would be required along with surface water treatment, storage, and pumping facilities. The cost of water from the Harquahala basin would be approximately $1,800 - $2,000/AF.

Photo provided by SRP

Best Practices That
Improve Water Use Efficiency

EXPAND AGRICULTURAL WATER CONSERVATION

Agricultural water conservation has been an integral part of Arizona's agriculture industry for decades. Water conservation is achieved using multiple approaches to reduce water use either on the farm or through an irrigation district or company. Agriculture is a for profit enterprise so the agricultural conservation practices must be profitable. Agricultural water conservation does not necessarily free up water for another user except when land fallowing agreements are established. Agricultural water conservation can benefit any planning area. The cost varies with methods used.


Photo provided by The Nature Conservancy

Drip Irrigation on Carrots Reduces Water Use 40% - 60%

ENHANCE AQUIFER STORAGE

Aquifer recharge is the process of storing renewable water resources in the ground for later use, to preserve the aquifer, or enhance stream flows. Types of water that can be recharged:

1. Reclaimed Water
2. Surface water
3. Urban Enhanced Runoff (UER)

The volume of water that can be recharged may vary significantly depending on the availability of each water supply. An aquifer recharge and recovery project consists of recharge basins, recovery wells, possibly groundwater treatment, storage, transmission, and pumping facilities. Water from aquifer storage and recovery facilities may cost between $800 and $1,500/AF and could benefit any planning area.


Photo courtesy of Cochise County

Palominas Flood Control and Recharge Project

MUNICIPAL WATER CONSERVATION

Municipal water conservation is the practice of finding ways to use less water with existing customers. Water conservation is applicable in any planning area where water use is high enough to benefit from water conservation. The amount of water that can be conserved varies widely depending on current practices. Savings can vary from a few percentage points to 30% of the potable demand over an extended period of time.

One of the most effective ways to conserve water is to implement landscaping policies for new developments that limit the amount of turf. It is easier to design water conservation into a new development than to retrofit an existing development.



Types of Xeriscaping to reduce water use

RECLAIMED WATER

Reclaimed water, sometimes also referred to as recycled water, is wastewater that is treated to a high standard that makes this water suitable for multiple uses.

Reclaimed water projects can be implemented in any planning area where a wastewater treatment facility exists. Reclaimed water projects can be combined with other augmentation project technologies such as aquifer storage of renewable water supplies. Reclaimed water recharge in an AMA provides the additional benefit that groundwater credits can be accrued for the water that is recharged. Permits issued by ADWR are required for recharge activities.


Photo courtesy of Sierra Vista

Reclaimed Water Recharge Facility

Reclaimed water can be used in a variety of ways, including the following:

- Indirect Potable Reuse (aquifer storage and recovery)
- Direct Potable Reuse
- Non-Potable Reuse (Direct Reuse) Reclaimed water delivered for industrial or irrigation uses
- Enhance aquifer storage and/or stream flows

Reclaimed water systems are valuable because they can recover up to 30% of the water delivered by a potable water system. Reclaimed water supplies increase with an increase in population.

Aquifer recharge and recovery projects may provide potable water between $800 and $1,500/AF. The cost of water using Direct Potable Reuse may vary between $1,000 and $2,000/AF. Direct reuse projects may cost as little as $200/AF.

Projects and Practices Between Willing Parties that Improve Water Management

WATER SUPPLY TRANSFERS FOR CAP AND COLORADO RIVER WATER USERS

Colorado River and CAP water users may execute an agreement with willing priority 1, 2, or 3 Colorado River water users to fallow land and voluntarily transfer water, with compensation, to deliver water to areas that are served by the Colorado River or CAP canal.

Transferring water supplies may benefit water users in the following planning areas: Colorado Main Stem North, Colorado Main Stem South, Basin and Range AMAs. The amount of water that could be transferred is unique to each agreement and the cost would be negotiated between willing parties.

MODIFY OPERATION OF THE ROOSEVELT DAM TO USE THE FLOOD CONTROL SPACE

Roosevelt Dam is operated by SRP. Modified Roosevelt Dam currently has ~556 kaf of storage designed as Flood Control space that was added as part of the Safety of Dams Act. The current Water Control Manual for the dam states that once water enters flood control space it must be evacuated within 20 days. This project proposed to take advantage of storage capacity in the flood control space when it is not needed for flood control through the use of Forecast Informed Reservoir Operations (FIRO). Water temporarily in flood control space could then be used for direct delivery and/or recharge for the Basin and Range Planning Areas. Recharge credits cannot be obtained with this water.

The volume of water that could be beneficially used by using the flood control space is not determined. Additional water available with this method is irregular and infrequent, but could be a valuable intermittent supply to a user who could take advantage of such a supply. Existing law limits the ability to recharge this water. Legislative changes could be made to maximize the benefit of flood control space use.

Because this project would not require new infrastructure, the associated costs would primarily be permitting and any associated mitigation.

Roosevelt Dam and Reservoir

SRP-CAP INTERCONNECT FACILITY

The SRP-CAP Interconnect Facility (SCIF) is a proposed project to connect SRP's South Canal with the CAP canal that together with the existing CAP-SRP Interconnect Facility (CSIF) will allow water to move between the SRP and CAP systems in both directions. This proposed facility would serve to build further regional water resiliency by increasing the flexibility of existing infrastructure. For example, water stored in New Conservation Space (NCS) in Roosevelt Lake is intended for use outside of SRP's boundaries, but can currently only be delivered using the SRP delivery system. The SCIF would facilitate delivery of this water to city water treatment plants outside of SRP's boundaries.

Granite Reef Dam and SRP, CAP Canals

In addition, the SCIF will facilitate the recovery and efficient delivery of the over 1.9 million acre-ft of long-term storage credits located within SRP's boundaries. Long-term storage credit holders can arrange to use SRP's wells for recovery. Then one or more of SRP's 270 wells would pump the stored water and deliver it to SRP customers in place of the SRP water they would normally receive. The SRP water would instead be diverted into the CAP canal using the SCIF allowing the long-term storage credit holder to take delivery of an equal amount of water at their CAP water treatment plant.

Water Augmentation Concepts Requiring Further Development

WEATHER MODIFICATION

Cloud seeding is a weather modification practice aimed at increasing precipitation in a target region by introducing seeding agents such as silver iodide into clouds to enhance the enlargement of cloud droplets and ice crystals with the intent to increase precipitation in the form of rainfall or snowpack. A permit is required from ADWR to do weather modification. Additional research and development is needed fully implement cloud seeding as an ongoing practice in Arizona.

Cloud Seeding Equipment

PHREATOPHYTE MANAGEMENT

Non-native phreatophytes such as salt cedar (Tamarisk) and Arundo (elephant grass) grow along the Gila River and its tributaries. These phreatophytes, along with some native species use large volumes of water thus reducing groundwater and streamflows. Phreatophytes have potential impacts on groundwater recharge, streamflow, and runoff, as well as environmental effects on carbon cycling and evapotranspiration rates. Phreatophyte removal requires ongoing maintenance. Phreatophytes could be replaced with lower water using plants. Active management and control of these plants have the potential to help improve water supplies in several Arizona River Basins (Lower Gila, Gila Bend, Basin and Range AMAs, Upper Gila, Verde, Lower San Pedro, Upper San Pedro).

Photo provided by the New York Times

Phreatophytes along the Colorado River

FOREST MANAGEMENT

Managing forests with water supply and quality in mind is essential to freshwater supplies in Arizona. Forest management practices that employ forest thinning and prescribed burns have been shown to increase water runoff, reduce fire risk and decrease evapotranspiration losses. Preventing large forest fires also improves water quality. The key benefits of forestry management are a higher surface water quality and a more resilient water supply.

More research is needed to quantify the influence of large-scale mechanical thinning efforts on runoff and to establish ongoing forestry management practices.

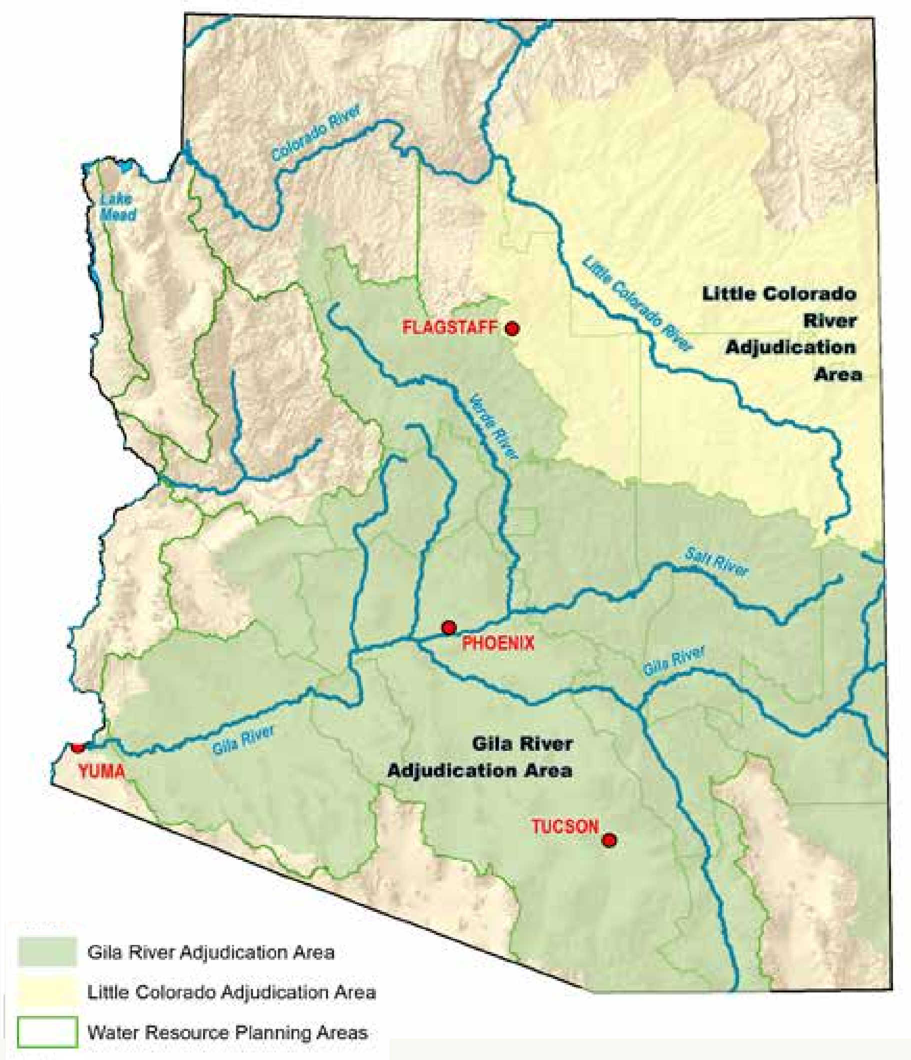
Forests in the Watershed to be Managed

Impediments to **Water Augmentation**

LITTLE COLORADO AND GILA RIVER WATER STREAM ADJUDICATIONS

Two ongoing water rights adjudications in state courts will resolve surface water claims in much of the state. The stream adjudications, which started in the 1970s, aim to quantify water rights and establish priorities within the Gila and Lower Colorado River basins, which cover most of the state. The watershed of the Gila and its tributaries - the Salt, Verde, Agua Fria, Santa Cruz, and San Pedro Rivers - cover most of the state's population and agriculture. The Gila River Adjudication, which is in the Maricopa County Superior Court, involves more than 32,000 claimants and 57,000 claims. The Little Colorado River Adjudication, which is in the Apache County Superior Court, involves more than 5,000 claimants and 30,000 claims. The adjudications will comprehensively settle all water rights claims on the river systems, a complex task that began more than 40 years ago and will take many more decades to resolve.

Since the 1970s, development has increased reliance on this water, the combined claims to which exceed the available supply. Eventual resolution of the claims in court means some current water users may no longer be able to use this water. This uncertainty presents a significant barrier to planning for future water needs and long-term reliability and prevents water users from assessing water augmentation needs. These claims also include environmental interests seeking water for instream flows, the needs of which can be difficult to evaluate without adjudicated water rights.



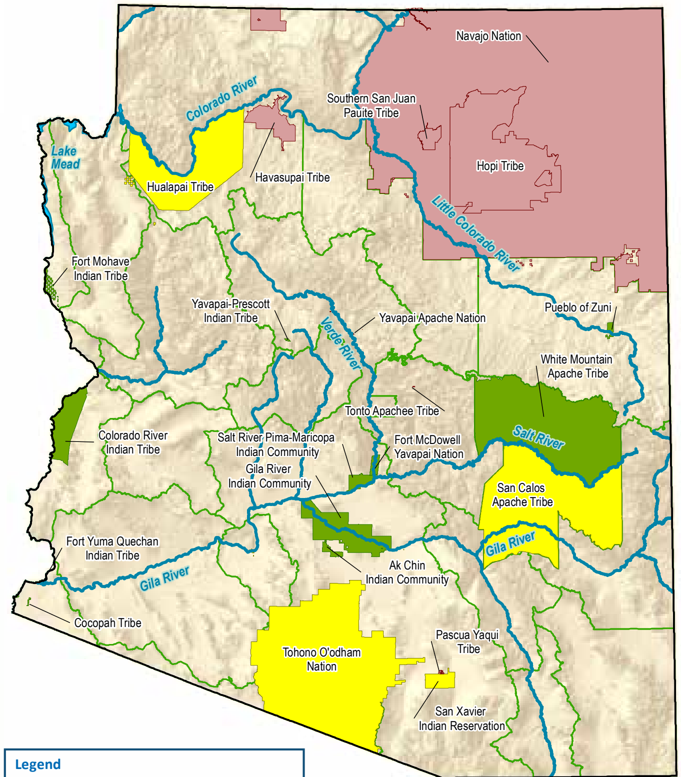
Land Areas affected by the Little Colorado and Gila River Water Rights Adjudications

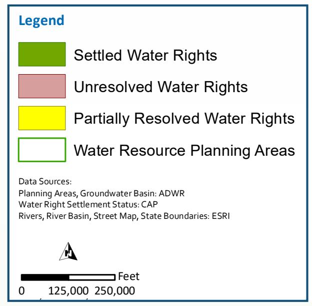
UNRESOLVED INDIAN WATER RIGHTS CLAIMS

There are 22 federally recognized tribes in Arizona with reservation land that covers nearly 28% of the state. Eleven of those tribes have reached water rights settlements with the State of Arizona. Three tribes have partial settlements and eight have unresolved claims. 67,300/AF of Colorado non-Indian agricultural (NIA) water has been held in reserve for Indian Water Rights claims. The unresolved water rights claims are an important part of the Little Colorado and Gila River Water Adjudications.

The settlement of unresolved tribal water rights claims is important not only from the perspective of justice for Native American communities, but also in terms of assessing statewide water availability. Tribal interests cannot fully participate in water augmentation planning across the state until their claims are resolved. The settlement of all claims will result in allocation of water supplies that are reserved for settlements, allowing tribes to assess their complete water supply portfolio and consider participation in augmentation projects.

The settlement of tribal water claims also provides the potential for collaborative augmentation options as permitted by the terms of the settlement. Some tribal entities currently lease a portion of their water allocations off reservation to non-Indian users. Unleased water represents water that could be available for off-reservation uses. The settlement of additional claims and tribal allocation of the additional CAP water could potentially result in more water available for leasing.

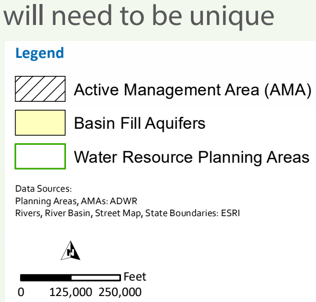




Status of water right settlements with Indian Tribes

LACK OF STATEWIDE GROUNDWATER MANAGEMENT PLANNING

The Groundwater Management Act of 1980 created AMAs which brought groundwater regulation to the state's most populated areas that were experiencing groundwater overdraft. Outside of these AMAs, groundwater use is essentially unrestricted, providing little incentive for communities to invest in new supplies because local resources are not quantified or protected. A groundwater management planning process involves quantifying groundwater resources, assessing the rate at which supplies are being depleted, setting goals for long-term reliability, and implementing sustainable practices and monitoring results. Evaluating augmentation needs and options are part of the overall planning process. Groundwater management strategies for rural areas will need to be unique in each area to address the specific needs of each planning area.



Alluvial Fill areas with groundwater

Acknowledgments

The Long Term Water Augmentation Committee of the Governor's Water Augmentation, Innovation and Conservation Council

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